

Fungi on Citrus from India

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Next to Mango and Banana, *Citrus* represents the third largest fruit industry of India and ranks 6th among the *Citrus* growing countries of the world. The principal regions of citrus cultivation in India lie in Madras, Madhya Pradesh, Maharashtra, Assam and Mysore.

Citrus fruits are esteemed primarily as articles of diet. They also provide a large number of commercial products such as essential and fatty oils (orange oil, lemon oil, lime oil etc.), citric acid, malic acid, minerals (Calcium, phosphorus and iron), glycosides, pectins, anthocyanins, B-carotene, Vitamin C & B, sucrose and other reducing sugars etc. Fruits are converted into beverages (juices, squashes etc.) and also some canned commercial products.

Oranges are the most refreshing delicious, wholesome and growth promoting juicy fruits. Limes and lemons are rich in vitamins, minerals and salts but are highly acidic. Their juice is mixed with sugar for the popular summer drink "the sherbat". They are also largely used for making pickles and thus preserved throughout the year. Oils obtained from orange, lemon and lime are used for flavouring purposes and also have some medicinal properties.

Citrus trees and fruits are subject to a number of diseases in the field as well as storage incited by fungi, bacteria and viruses of which the fungal diseases predominate. As a result, heavy crop losses are experienced by the orchard owners and also by the 'Fruit Canning Industries'. A number of fungi have been reported on various citrus species from India, an account of which has been published from time to time. A perusal to the 'Indian Literature' shows the scattered nature of this information. Attempt has been made to bring all this information in a single publication, which will serve as useful reference work for future investigators.

The present paper aims to give an up-to-date list of "Fungi" reported on various *Citrus* spp. from India so far, together with nature of diseases incited by them and relevant literature on the subject.

It is hoped that a publication of this nature would be of great value to the mycologists, plant pathologists, horticulturists and also to the plant protection and quarantine authorities.

The *Citrus* species as well as the Fungi affecting them are arranged alphabetically.

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A statement showing different Fungi responsible for diseases of Citrus in India

1. Causal Fungi	2. Nature and Type of Disease. — Remarks
I. <i>Citrus acida</i> var. <i>variegata</i> L. <i>Colletotrichum gloeosporioides</i> Penzig	Leaf blight Rai (1956) reported from Lucknow (U. P.)
II. <i>Citrus assamensis</i> Bhattacharya & Datta. <i>Septobasidium pseudopedicellatum</i> Burt.	'Felt' disease Common and widespread in Assam, Chowdhury (1951).
III. <i>Citrus aurantifolia</i> (Christm.) Swingle <i>Aschersonia raciborskii</i> Zimm.	— On <i>Aleyrodes</i> infecting the leaves, Banares (U. P.) and also reported by Uppal et al (1935). Reported by Uppal et al (1935). General.
<i>Diplodia citrina</i> Diedike <i>Diplodia natalensis</i> Evans	Twig blight Twig blight & Fruit rot
<i>Fusarium solani</i> f. sp. <i>aurantifoliae</i> (Bhat. & Prasad)	Wilt
<i>Gloeosporium limetticolum</i> Clausen	Anthracnose & Fruit-fall
<i>Meliola butleri</i> Syd.	Sooty mould
<i>Phyllosticta aurantiicola</i> (Berk. & Cke.) Sacc.	Leaf spot
<i>Pleosphaeria citri</i> Arnaud	Leaf spot
<i>Trametes cervina</i> (Schw.) Bres.	Limb-break
<i>Tryblidiella rufula</i> (Spreng.) Sacc.	Canker & Die-back.
IV. <i>Citrus aurantium</i> L. (Sour, Bitter orange)	
<i>Alternaria tenuis</i> Auct.	Fruit rot General.

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<i>Botryodiplodia theobromae</i> Pat.	Soft rot & twig blight. General.
<i>Cephalosporium</i> sp.	Fruit rot. Reported rarely in literature.
<i>Colletotrichum gloeosporioides</i> Penz.	Anthraxnose & Die-back. General throughout India.
<i>Daldinia eschscholzii</i> (Ehrenb.) Rehm.	Charcoal rot. On wood, reported from Nagpur.
<i>Diplodia indica</i> Diedicke	Saprophyte. Reported on bark (Poona).
<i>Haplosporella hesperidica</i> Speg.	Saprophyte. Reported from Coorg (Mysore) on dead branches.
<i>Illosporium citri</i> Muthappa.	Saprophyte. On dead twigs, Coorg Forests (Mysore), Muthappa (1966 a).
<i>Meliola butleri</i> Syd.	Sooty mould. General distribution.
<i>Meliola camelliae</i> (Catt.) Sacc.	Sooty mould. Reported from Dehra Dun, Pusa etc.
<i>Nigrospora oryzae</i> (Berk. & Br.) Petch.	Saprophyte. Reported by Srivastava et al (1964) in storage.
<i>Oidium tingitanum</i> Carter	Powdery mildew. Reported from Kotagiri & Shevroy hills of S. India. The fungus covers leaves, twigs and fruits and causes drying.
<i>Oospora citri-aurantii</i> (Ferrar) Sacc. & Syd.	Slimy fruit rot. General in storage.
<i>Pellicularia alba</i> (Dastur) Dastur (Syn = <i>Corticium album</i> Dastur)	Pink disease. On living stems, Burhanpur (M.P.), Dastur (1940).
<i>Pellicularia salmonicolor</i> (Berk. & Br.) Dastur (Syn = <i>Corticium salmonicolor</i> Berk. & Br.)	Pink disease. Severe in high rainfall tracts of Assam, Balanghat (M.P.), as reported by Dastur (1941) and also at North Arcot & Chittoor Districts of Madras.
<i>Phytophthora palmivora</i> Butler	Fruit decay, Gummosis. General.
<i>Phytophthora parasitica</i> Dastur	Fruit decay. General.
<i>Penicillium fellutanum</i> Biourage	Fruit decay. General.
<i>Spaceloma fawcetti</i> Jenkins	Scab (Ashy). On leaves and fruits, general, first recorded by Patel, Kamat & Bhide (1949), Poona.

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V. <i>Citrus crysocarpa</i> Lushington	
<i>Alternaria citri</i> Pierce	Leaf spot
<i>Aspergillus niger</i> van Tiegh.	Fruit rot
<i>Botrytis cinerea</i> Pers.	Fruit rot
<i>Cladosporium herbarum</i> Lk. var. <i>citricola</i> Fawcett & Burger	Fruit rot
<i>Fusarium moniliforme</i> Sheldon	Fruit rot
<i>Penicillium digitatum</i> Sacc.	Fruit rot
<i>Penicillium expansum</i> Link.	Fruit rot
<i>Penicillium italicum</i> Wehmer	Fruit rot
<i>Stysanus monilioides</i> (Alb. et Schw.) Corda	Fruit rot
<i>Trichoderma lingorum</i> (Tode) Herz.	Fruit rot
VI. <i>Citrus limonia</i> Risso	
<i>Calosphaeria fici</i> Kale	Saprophyte
<i>Curvularia tuberculata</i> Jain.	Die-back
<i>Alternaria citri</i> Pierce	Leaf spot
VII. <i>Citrus limonum</i> (L.) Brum.	
<i>Alternaria citri</i> Ell. & Pierce.	Leaf spot & fruit rot
<i>Fusarium limonis</i> Briosi	Seedling disease
<i>Fusarium lateritium</i> Nees.	Root & Stem rot
<i>Phyllosticta desciformis</i> Penz.	Leaf spot
<i>Hysterium citricola</i> Tilak & R. Rao.	Saprophyte

Reported from Kalimpong (W. Bengal).

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Reported from Calcutta (W. Bengal)

Reported from Kalimpong (W. Bengal).

Reported from Kalimpong (W. Bengal).

Reported from Kalimpong and Allahabad.

Reported from Kalimpong, Darjeeling (W. Bengal) by Roy (1941).

Reported from Kalimpong (W. Bengal).

On dead branches, Bhir (Maharashtra), Kale (1967).

Serious disease, reported recently from Delhi (Lele et al 1968).

General, Agarwal & Hasija, reported from Jabalpur (1961).

General.

Rare occurrence.

Allahabad and Dehra Dun (U. P.)

Reported by Roy (1968) from Borbheta (Assam).

An Ascomycete on dried stems (Tilak & R. Rao, 1966) described this from Aurangabad (Maharashtra).

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VIII. <i>Citrus maderaspatana</i> Hort. ex Tanaka	
<i>Diplodia</i> sp. <i>Sporocybe hybrida</i> Mason	Saprophyte — Recorded on the branches. Isolated from the roots, Madras.
IX. <i>Citrus maxima</i> (Burm.) Merrill (Shaddock) (= <i>Citrus decumana</i> L. = <i>C. grandis</i> (L.) Osbeck) <i>Diplodia natalensis</i> Pole Evans	Twig blight & Fruit rot General.
<i>Helminthosporium</i> sp. <i>Hypochoydon deustum</i> (Hoff. ex Fr.) Grev.	Fruit spots Charcoal Stump-rot Rare, Tandon & Varma (1964). Reported by Agnihothrudu (1964) from Toklai (Assam).
<i>Pestalotia citri</i> Mundk. & Kheswalla <i>Phoma nainiensis</i> Bilgrami	Leaf spot Leaf spot Recorded from Kirkee, Poona. Reported from Naini (Allahabad), described by Bilgrami (1963).
<i>Pleospora herbarum</i> (Pers.) Rabenh. <i>Phomopsis citri</i> Fawcett	Leaf spot Melanose Reported from Allahabad by Bilgrami (1963). Widespread in Assam with high rainfall (Chowdhury 1955).
<i>Sclerotium rolfsii</i> Sacc.	Die-back Reported from Kottayam (Kerala), attack branches.
<i>Septobasidium pseudopedicellatum</i> Burt. <i>Sphaceloma fawcettii</i> Jenkins	Felt disease Scab First reported by Chowdhury (1951) from Assam.
X. <i>Citrus medica</i> L. <i>Alternaria citri</i> Ell. & Pierce.	General Black rot General in storage. Recently reported by Agarwal & Hasija (1967) from Jabalpur.
<i>Ascochyta citri</i> Penz. <i>Chaetomium orientum</i> Saha <i>Colletotrichum gloeosporioides</i> Penzig.	Leaf spot Saprophyte Anthracnose & wither tip or die-back Reported from Kumaon (U. P.) On wood (Saha 1964). Throughout India.

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<i>Diplodia citrina</i> Died. <i>Fusarium semitectum</i> Berk. & Rav. <i>Gloeosporium spegazzinii</i> Sacc. <i>Melanomma citricola</i> Syd. & Butler <i>Mycosphaerella citricola</i> Tilak <i>Septoria cattanei</i> Thuem. <i>Tryblidiella rufula</i> var. <i>microspora</i> Ell. & Ev.	Root rot Fruit rot Anthracnose Black bark spot Leaf-blight Leaf spot Saprophyte Reported from Sholapur (Maharashtra), rare. Allahabad (U. P.) Allahabad (U. P.) Barnihat (Assam) First described by Tilak (1963) from Poona. Kanara (Mysore). An Ascomycete on dead twigs, Varanasi (U. P.)
XI. <i>Citrus medica</i> var. <i>acidula</i> L. (Lemon, Nimbu) <i>Aspergillus niger</i> v. Tiegh. <i>Botryodiplodia theobromae</i> Pat. <i>Cladosporium herbarum</i> (Pers.) Link <i>Curvularia lunata</i> (Wakker) Boedijn <i>Fusarium semitectum</i> Berk. & Rav. <i>Geotrichum candidum</i> Link. <i>Glomerella cingulata</i> (Stonem.) Spauld. & Shrenk. <i>Memnoniella echinata</i> (Riv.) Galloway <i>Meliola amphitricha</i> Fr. <i>Phoma macrophoma</i> McAlp. <i>Phyllostica limonum</i> Lucas & Da Camara. <i>Sphaeropsis tumefaciens</i> Hedges & Tenny.	Soft rot Fruit rot Fruit spot Fruit spot Soft rot (Fruits) Waxy rot Anthracnose General on fruits, in storage. General on fruits. Tandon & Varma from Allahabad (1964). Tandon & Varma from Allahabad (1964). General. General, first report by Rao (1966) from Poona. General. Soft rot Sooty mould. Wither-tip. Leaf blight Leaf spot, tumors or branch knots.
XII. <i>Citrus nobilis</i> Lour. var. <i>deliciosa</i> Sw. <i>Diplodia natalensis</i> Pole Evans. <i>Phytophthora palmivora</i> Butler	General. General. General. General.

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XIII. <i>Citrus paradisi</i> Macf. (Grape Fruit)	
or <i>Papnas</i> .	
<i>Elsinoë fawcetti</i> Bitanc. & Jenkins.	Leaf spots
<i>Geotrichum candidum</i> Link.	Waxy rot in storage.
<i>Gloeosporium citri</i> Cke. & Mass.	Fruit rot
<i>Pythium debaryanum</i> Hesse	Seedling rot.
<i>Rhizoctonia solani</i> Kuehn.	Seedling rot.
<i>Uredo citri</i> Cooke	Rust.
	Reported from Kallar (Madras). General on fruits. General. Kanpur (U. P.). Kanpur (U. P.) Alisagar (Hyderabad Dn.), Reported by Vaheeduddin (1955).
XIV. <i>Citrus reticulata</i> Blanco (Mandarin orange) (= <i>C. nobilis</i> Lour.)	
<i>Alternaria tenuis</i> Auct.	
	Black core rot.
<i>Meliola butleri</i> Syd.	Sooty mould.
<i>Penicillium digitatum</i> Sacc. (Green mould)	Fruit rot
<i>Penicillium italicum</i> Wehmer (Blue mould)	Fruit rot
<i>Phomopsis citri</i> Fawcett	Melanose
<i>Phytophthora palmivora</i> Butler	Leaf fall & fruit rot
<i>Septobasidium pseudopedicellatum</i> Burt.	'Felt' disease
<i>Uromyces nilagiricus</i> Ramakr. T. S. & K.	Rust.
<i>Rhizoctonia bataticola</i> (Taub.) Butler.	Fruit rot
	General, detailed studies by Singh & Khanna (1966). General. General. General. Widespread in Jorhat, Burnihat (Assam), Chowdhury (1955). Serious at moist zones of Wynad & Coorg, (S. India). Wide-spread in Assam. (Chowdhury 1951). On leaves of <i>Loranthus</i> sp. parasitic on <i>Citrus reticulata</i> , Kotagiri (Madras). First reported by Parashar & Chohan (1966) from Ludhiana (Punjab).
XV. <i>Citrus sinensis</i> (L.) Osbeck. (Munsambi) (Lemon, Sweet orange)	
<i>Alternaria citri</i> Pierce	Leaf spot & fruit rot.
	General. First recorded by Uppal, Patel & Kamat from Poona (1935).

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<i>Aspergillus fumigatus</i> Fres.	Fruit
<i>Botryodiplodia theobromae</i> Pat.	Leaf spot & fruit rot
<i>Colletotrichum gloeosporioides</i> Penz.	Anthraxnose
<i>Diplodia indica</i> Died.	Bark infection.
<i>Diatrype verruciformis</i> (Ehr.) Nke.	Saprophyte
<i>Fusarium moniliforme</i> Sheldon	Fruit rot.
<i>Fusarium solani</i> (Mart.) App. & Wollenw.	Twig blight.
<i>Gloeosporium citri</i> Cke. & Mass.	Anthraxnose
<i>Haplosporella cosmopolitus</i> Muthappa	Saprophyte
<i>Illosporium citri</i> Muthappa	Saprophyte
<i>Meliola citricola</i> Syd.	Sooty mould
<i>Nectria heterosperma</i> Kalchbr. & Cooke.	Cankers (Orange)
<i>Phomopsis citri</i> Fawcett (Perfect = <i>Diaporthe citri</i> (Fawcett) Wolf)	Melanose
<i>Phytophthora palmivora</i> Butler	Gummosis.
<i>Rhizoctonia bataticola</i> (Taub.) Butler	Fruit rot
<i>Rhizopus stolonifer</i> (Fr.) Linder	Fruit rot
<i>Rosselinia bunodes</i> (Berk. & Br.) Sacc.	—
<i>Septobasidium citricolum</i> Sawada	Black felt.
<i>Trametes cervina</i> (Schw.) Bres. (Agaricales)	Limb breakage
<i>Trichurus gorgonifer</i> Bain.	Fruit infection
<i>Tryblidiella rufula</i> (Spreng.) Sacc.	Saprophyte
	Sinha (1964). General. Common. Poona. (Uppal, Patel, Kamat, 1935). On dead branches, Muthappa (1966). General, first recorded by Ghatak (1938). Darjeeling and Sikkim (Chatopadhyay & Sen Gupta 1967). General. On dead branches at Coorg, Muthappa (1966). On dead twigs at Coorg, Mysore, Muthappa (1966). General. On branches causing die-back. Bombay (Uppal et al, 1935). Widespread in Assam (Chowdhury 1955 b). Detailed study by Uppal & Kamat (1936), a leaf fall disease by Devarajan & Aiyappa 1945) from Coorg. General. General. Recorded by Uppal, Patel & Kamat (1935), Bombay. General. Reported from N. Arcot & Cuddapah (Andhra) by Ramakrishnan (1955). Calcutta (West Bengal). An ascomycete on dry twigs, at Coorg (Mysore).

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XVI. <i>Citrus</i> sp.	
<i>Aspergillus fumigatus</i> Fres.	Damping-off. A seedling disease, recently reported by Lele et al. (1967) from New Delhi.
<i>Botrytis cinerea</i> Pers.	Gray-gummosis. A serious disease in Assam.
<i>Capnodium citri</i> Berk. & Desm.	Sooty mould On leaves and fruits, General.
<i>Cercospora penzigii</i> Sacc.	Leaf spot. Pusa (Bihar).
<i>Chaetomium</i> sp.	Saprophyte Rarely reported.
<i>Cladosporium herbarum</i> Link.	Black mould. On leaves and fruits, common in Assam.
<i>Colletotrichum capsici</i> (Syd.) Butler.	Anthrachnose On leaves and fruits, reported from Bihar.
<i>Curvularia lunata</i> (Wakker) Boedijn.	Leaf spot Chaudhuri (1936) from Punjab.
<i>Cytospora citri</i> Died.	Leaf spot On fading leaves, Pusa (Bihar).
<i>Macrophoma paraphysata</i>	— Reported by Lal (1960) from Bombay.
<i>Dothiorella phaseoli</i> (Mauhl.) Petr.	Root rot From Poona (Uppal, Patel & Kamat, 1935).
<i>Phoma macrophoma</i> McAlp.	Twig blight From Poona (Uppal, Patel & Kamat, 1935).
<i>Pleospora herbarum</i> (Pers.) Rabenh.	Leaf spot General.
<i>Pythium debaryanum</i> Hesse	Damping-off Seedling disease in nursery (Srivastava & Singh, 1954).
<i>Rhizoctonia solani</i> Kuhn.	Damping-off Seedling disease in nursery (Srivastava & Singh, 1954).
<i>Rhizopus</i> sp.	Fruit rot General.
<i>Rhynchodiplodia citri</i> Briosi & Farnetti	Fruit rot Reported by Uppal, Patel & Kamat (1935), from Poona.
<i>Rhytidhysterium rufulum</i> (Spreng.) Petrak.	Saprophyte An Ascomycete, rare.
<i>Sporocybe hybrida</i> Mason.	Root infection Reported from Madras.
<i>Tryblidiella rufula</i> (Spreng) Sacc.	Saprophyte An Ascomycete on dead branches, Pulliyanur (Travancore-Cochin).

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